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# SWISS CHANNEL-TYPE GAGING STATIONS

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Agricultural Research Service

UNITED STATES DEPARTMENT OF AGRICULTURE

# SWISS CHANNEL-TYPE GAGING STATIONS[1]

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The water-measuring stations described in this report were developed by the Switzerland Federal Service of Hydraulic Economy, National Hydrography Subdivision. Detailed plans, photographs, and rating curves for four stations furnished by F. Chavez, Assistant Director of the Federal Service of Water Resources, Switzerland, were studied and abstracted for presentation herein.

These stations were developed to measure water in mountain streams having a heavy bedload, particularly during flood stages. An essential performance requirement for the station was that this bedload should not be deposited in the structure when the flow decreased. Performance of the flumes indicates that this requirement has been met.[3] In design principle these flumes are like the Tombstone Flumes[4] which also have shown freedom from deposition. Since the type of flume represented by the Swiss gaging station fills a need in the hydrologic research program of the Soil and Water Conservation Research Division of the Agricultural Research Service, information on the flumes is condensed into this brief report.

Each station is described separately. Along with the description is a sketch of the station, a photograph, and an estimated rating curve. For the purpose of estimating the head-discharge relationship the water was assumed to be at critical depth at the upper end of the straight part of the station. Then the water-surface profile was calculated from this point to the measuring section to obtain the estimate of head for a selected discharge. The plotted points on the rating curves were obtained from current meter measurements. The points represent the actual rating for the station; the curve has also been extended to provide an estimate of the head-discharge relationship in the ungaged range.

## Drance de Bagnes Station Near Le Chable, Switzerland

This station is a flume with a concrete floor and rubble masonry sides. The small center channel and part of the sloping sides are lined with steel. This lining was placed in the flume to reduce friction in order to obtain the needed flow velocity on the slight (0.5 percent) slope. See figure 1 for a sketch of this structure.

The head measuring section is located far enough downstream from the entrance to be in a zone of fairly uniform flow. Also, it is far enough upstream from the lower end of the flume to be unaffected by the exit conditions.

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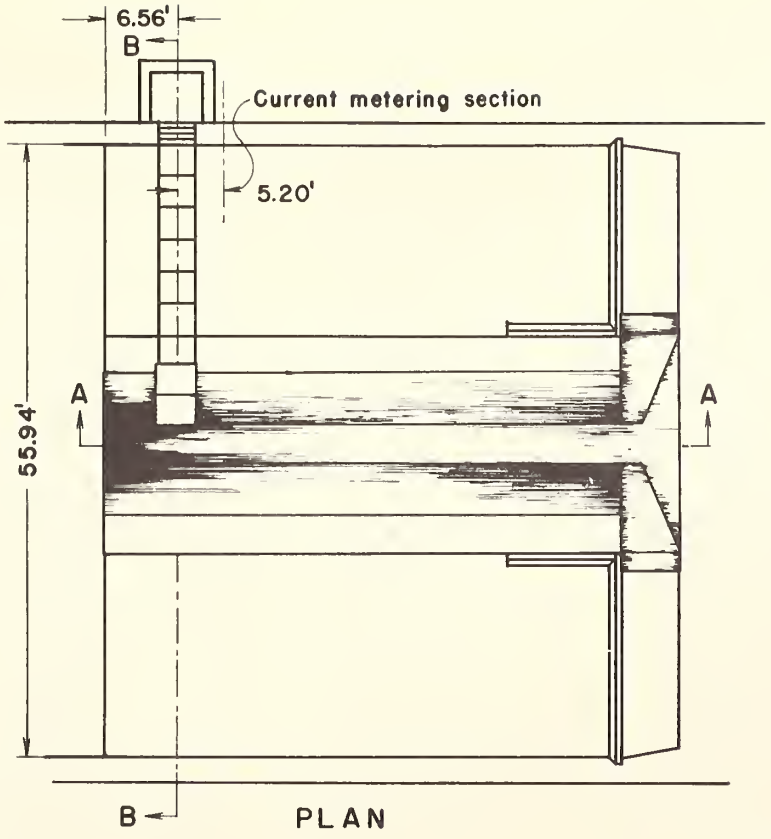
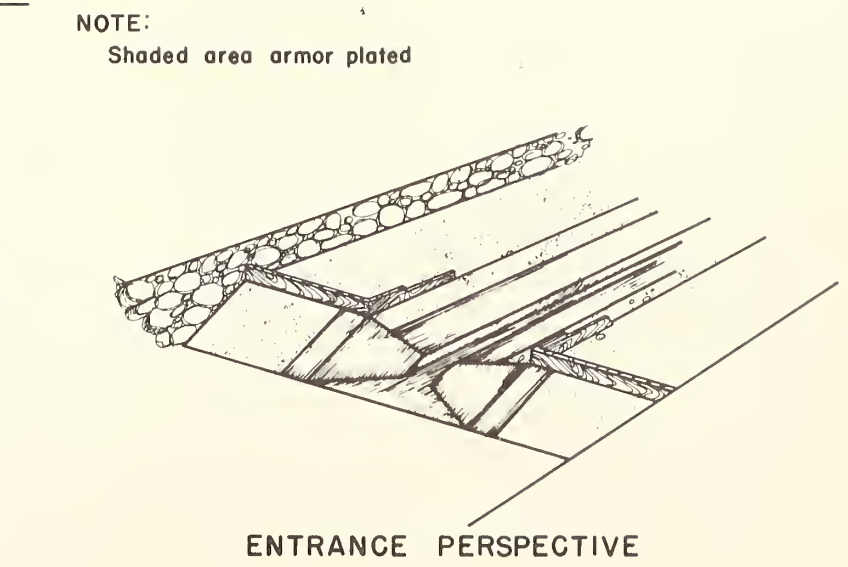
[1] Contribution from the Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture in cooperation with the Oklahoma Agricultural Experiment Station.

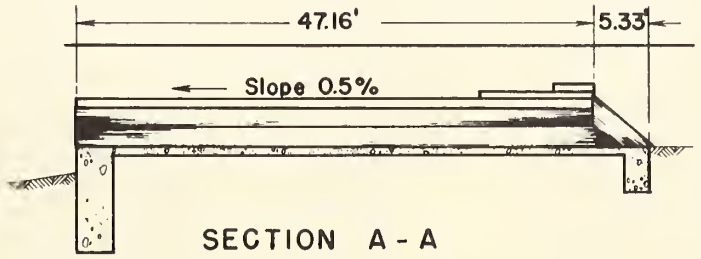
[2] Research Investigations Leader, Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, Stillwater, Okla.

[3] Communication from F. Chavaz, Federal Service of Water Resources, Berne, Switzerland, to L. L. Kelly, Soil and Water Conservation Research Division, Agricultural Research Service, dated April 22, 1964.

[4] Gwinn, W. R. The Walnut Gulch Supercritical Measuring Flume. Amer. Soc. Agr. Engin. Trans. 1964. (In Press.)



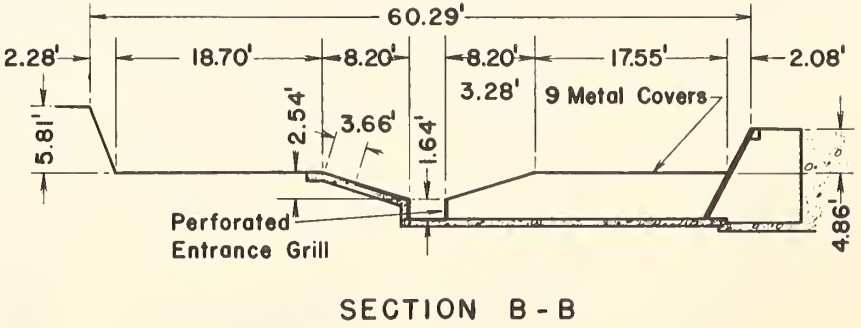




Figure 1.--Drance de Bagnes Water-Measuring Station near Le Chable, Switzerland. Sketch abstracted from plan number 16359 of the Federal Water Service, Switzerland.

The gage-well intake is a perforated plate in one of the vertical sides of the small center channel. Because the plate is vertical, sediment cannot enter the gage well so easily as it could if the plate were horizontal. Also, another advantage is that the head is measured at only one point in the cross section.

The entrance is sharp cornered, and the transition is rather abrupt. This causes contraction near the entrance with subsequent expansion and diagonal waves immediately downstream (fig. 2.). However, the flume appears to be sufficiently long to produce satisfactory flow conditions at the point of head measurement. Curved entrance walls would have reduced disturbances in the flow. Straight walls are preferred, however, because of their lower cost. Model studies are being made at the Laboratory for Hydraulic Research and Soil Mechanics at the Federal Institute of Technology in Zurich, Switzerland, to develop a suitable entrance shape built of straight sections.

The low transverse walls at the entrance are intended to direct the water into the center channel. Presumably the elevation of the top of these walls is the level of the head water for that discharge that completely fills the center channel. If they were not in place, some of the water for discharges in this particular range would flow over the flat portions of the flume floor and not be contiguous with the main body of water in the center channel. This could lead to inconsistencies in the head-discharge relationship. Although these walls solve this problem, they may disturb the flow for the higher discharges and may catch debris. An analysis of the head-discharge characteristics indicated that for these high discharges the flow depth just below the walls would be less than normal depth. A jump would not form because the slope of the flume floor is hydraulically steep, but the decelerating flow might be disturbed at the head measuring section.

The head-discharge relationship (fig. 3) shows good sensitivity of discharge measurement in the 0- to 4-foot range. With a head of over 4.2 feet the water starts to flow over the flat floor of the flume. Discharge capacity then increases rapidly with increasing head but with attendant loss in sensitivity. The estimated rating departs from the measured rating more for this station

Figure 2.--Drance de Bagnes Water-Measuring Station near Le Chable, Switzerland, viewed from downstream.

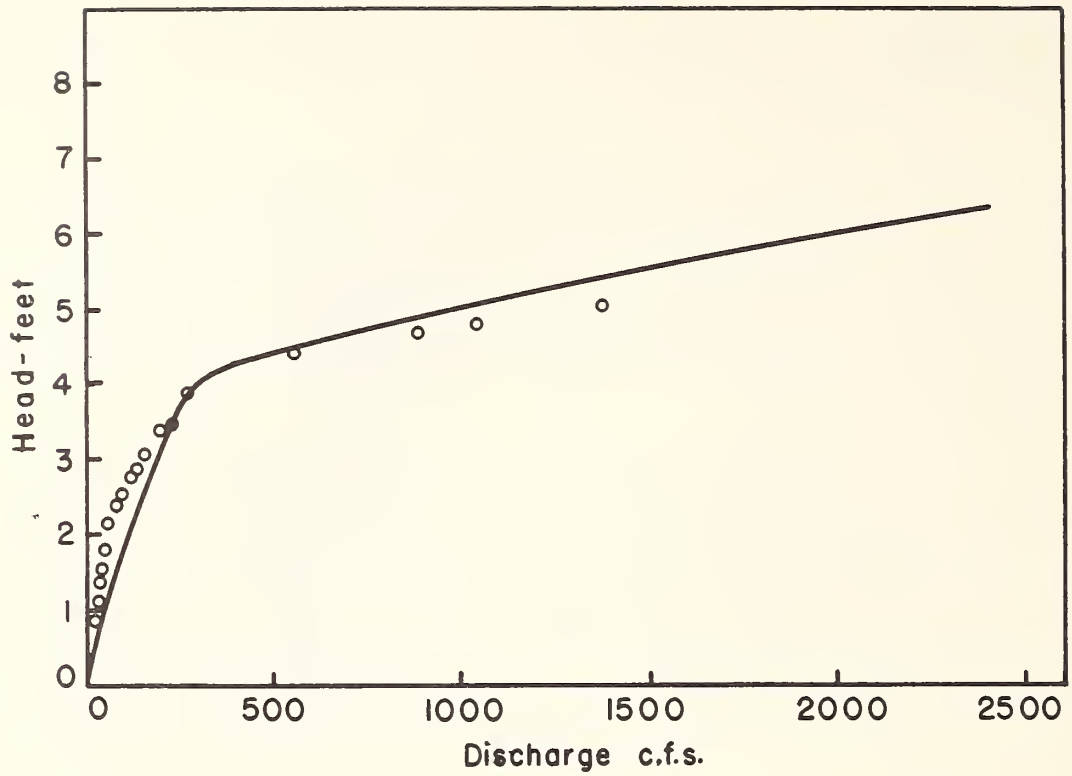



Figure 3.--The estimated head-discharge relationship for the flume shown in figures 1 and 2.

than for the other stations discussed in this report. Evidently the effect of the entrance boards was difficult to predict. Current meter measurements are needed to obtain the actual rating. The metering bridge is, therefore, an essential part of this installation.

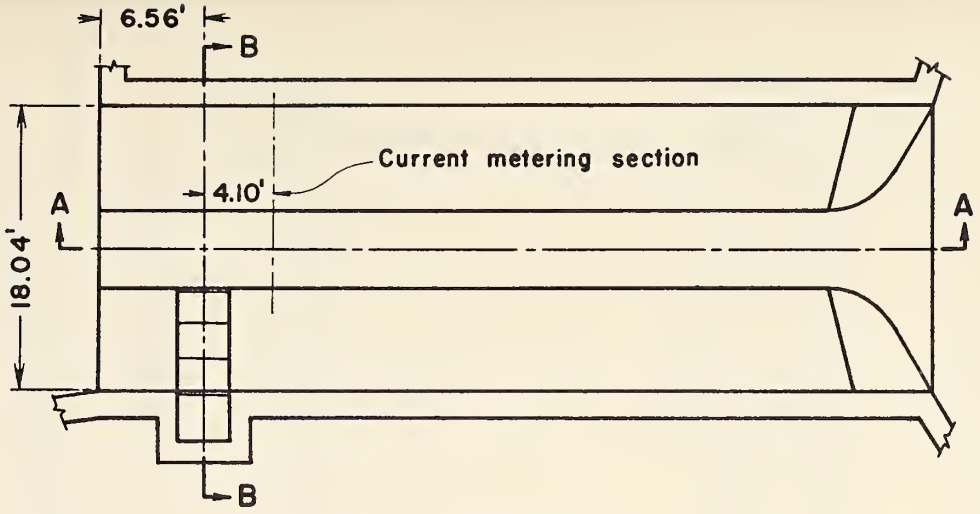
This type of water-measuring station is suitable for use in relatively steep, debris-laden streams. However, it should be used only in readily accessible locations, because of the need for making current meter measurements for calibration.

## Borgne Station Near La Luette, Switzerland

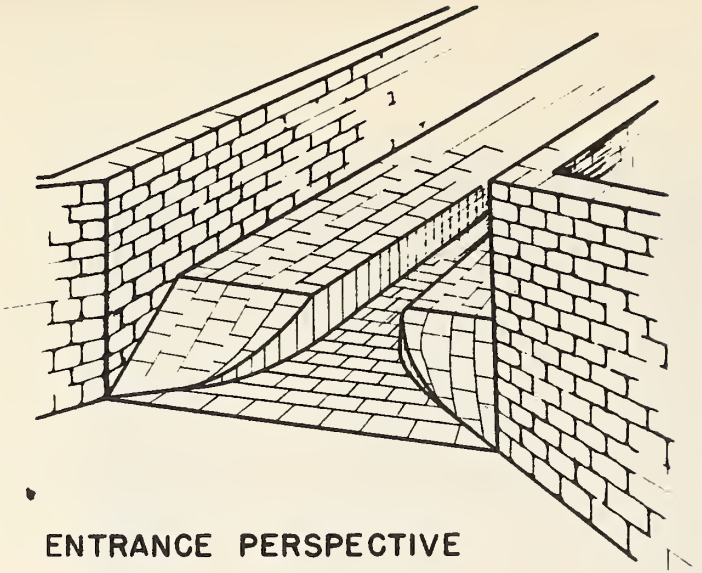
This station is a flume constructed entirely of masonry. A small center channel and adjacent sloping floors are built of very carefully fitted stone and are quite smooth. The outside walls are of ordinary coursed masonry and are somewhat rougher. Presumably the rock in the floor is abrasion resistant and is satisfactory for the debris flows experienced at this site. See figure 4 for a sketch of this station.

The approach channel makes a sharp turn just before it enters the station. This could cause some disturbance of the flow, but no information is available to this effect. For a small flow (fig. 5), the performance appears to be satisfactory. The curved entrance should be helpful in improving flow characteristics in the range of the smaller discharges. The comments made about the Drance de Bagnes Station head measuring section and intake system also apply here.

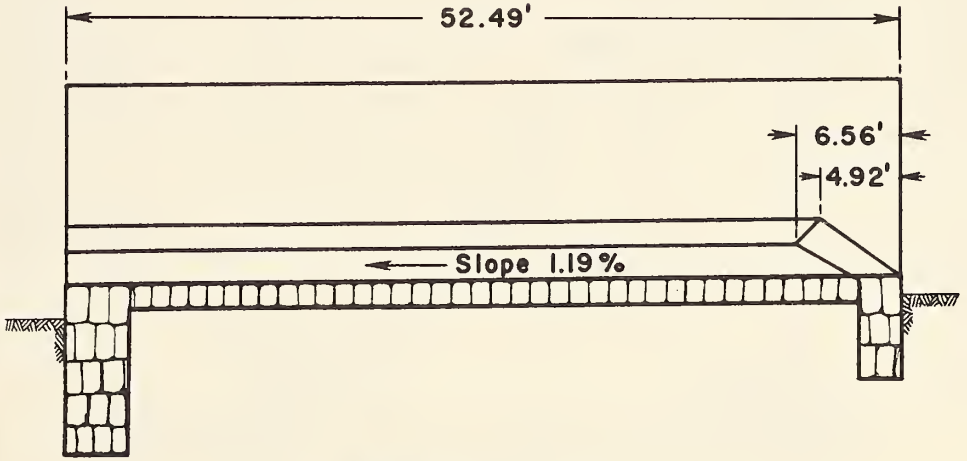
The head-discharge relationship for this flume is shown in figure 6. A Manning's n value of 0.014 was used for the smallest discharge and 0.020 for the largest discharge in the calculation of water-surface profiles needed to estimate the head-discharge relationship. Intermediate



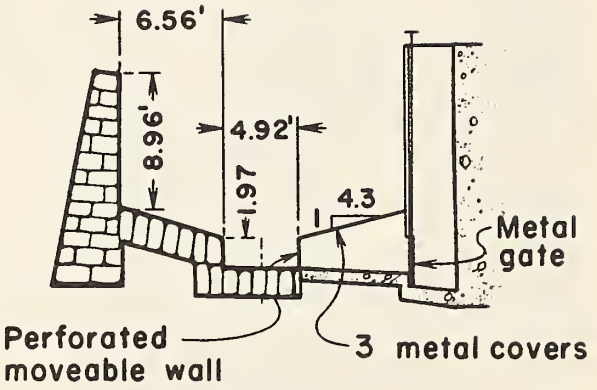

PLAN



ENTRANCE PERSPECTIVE




SECTION A-A




SECTION B-B

Figure 4.--Borgne Water-Measuring Station near La Luette, Switzerland. Sketch abstracted from plan number 10076 of the Federal Water Service, Switzerland.

Figure 5.--Borgne Water-Measuring Station near La Luette, Switzerland.

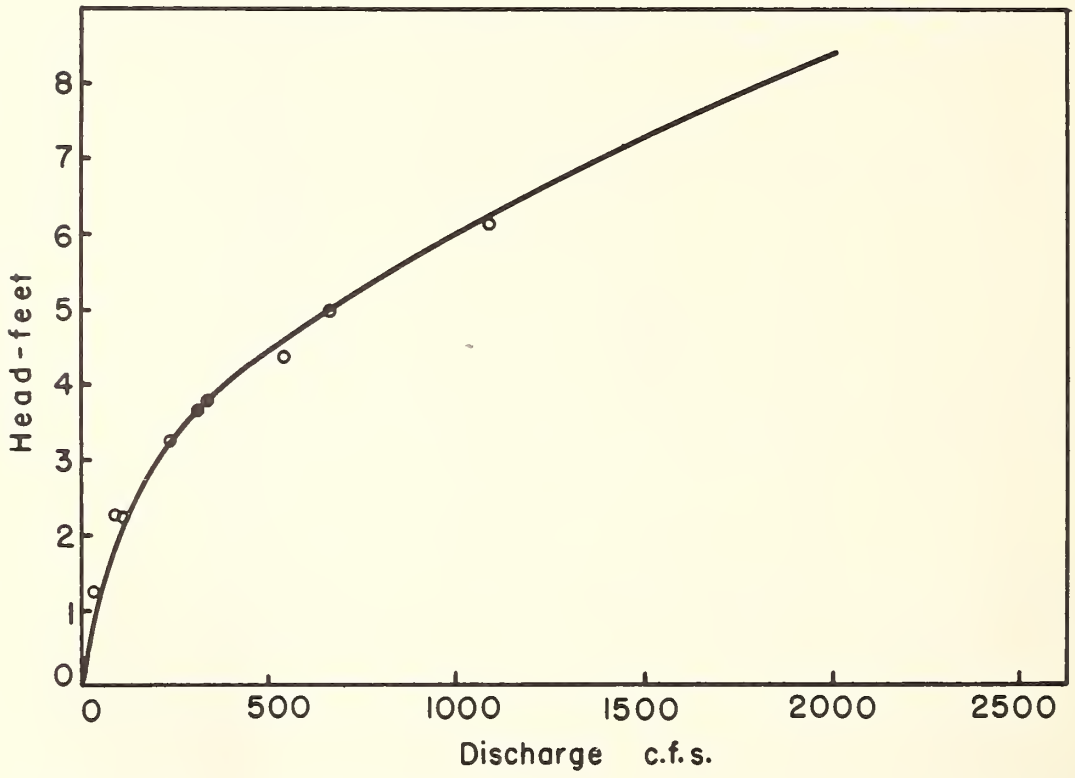



Figure 6.--The estimated head-discharge relationship for the flume shown in figures 4 and 5.

values of n were used for the discharges in between. Comparison of the estimate with the measurement showed the agreement to be very good for discharges greater than 200 cubic feet per second. One point in this higher range exceeded the estimate by about 11 percent, but it also deviated from the trend of the other current meter measurements. This agreement indicates that a careful analysis of the hydraulic properties of the measuring device can provide an estimate of the head-discharge relationship for this type of water-measuring station. This station shows good measurement sensitivity throughout its range.

This station is suitable for use in steep, debris-laden streams. Current meter calibration is necessary; hence, its use should be limited to readily accessible locations.

## Ova da Cluozza Station Near Zernez, Switzerland

Concrete is used in the construction of this station except for the floor of the small center channel, which is built of masonry. Gently tapering training walls provide a transition from the stream channel to the water-measuring station. Also, a longer curved entrance portion is used than in the two stations previously described. These design features indicate that woody trash can be expected here. See figure 7 for a sketch of this station and figure 8 for a photograph of it.

A Manning's n value of 0.014 was used in the calculation of water-surface profiles needed to estimate the head-discharge relationship (fig. 9). Fair to good sensitivity is indicated throughout the operating range of this station.

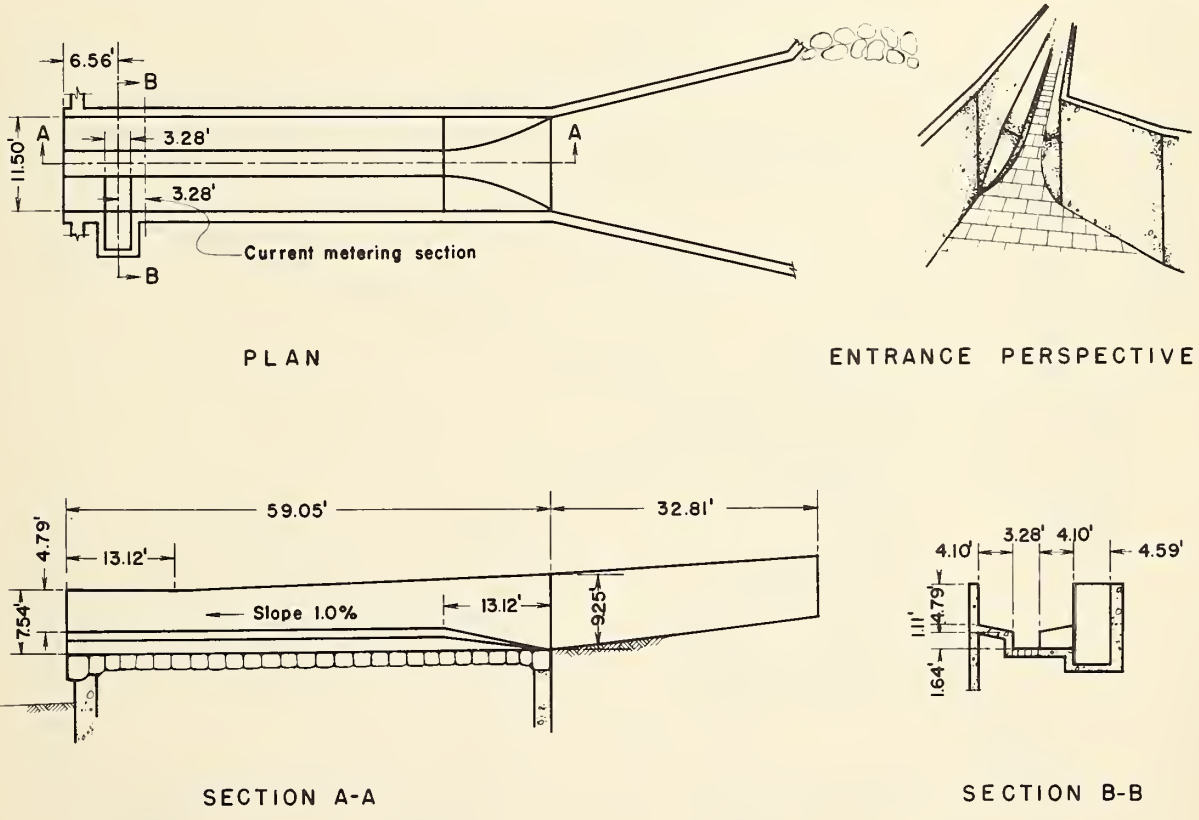



Figure 7.--Ova da Cluozza Water-Measuring Station near Zernez, Switzerland. Sketch abstracted from plan numbers 15783 and 15785 of the Federal Water Service, Switzerland.

Figure 8.--Ova da Cluozza Water-Measuring Station near Zernez, Switzerland.

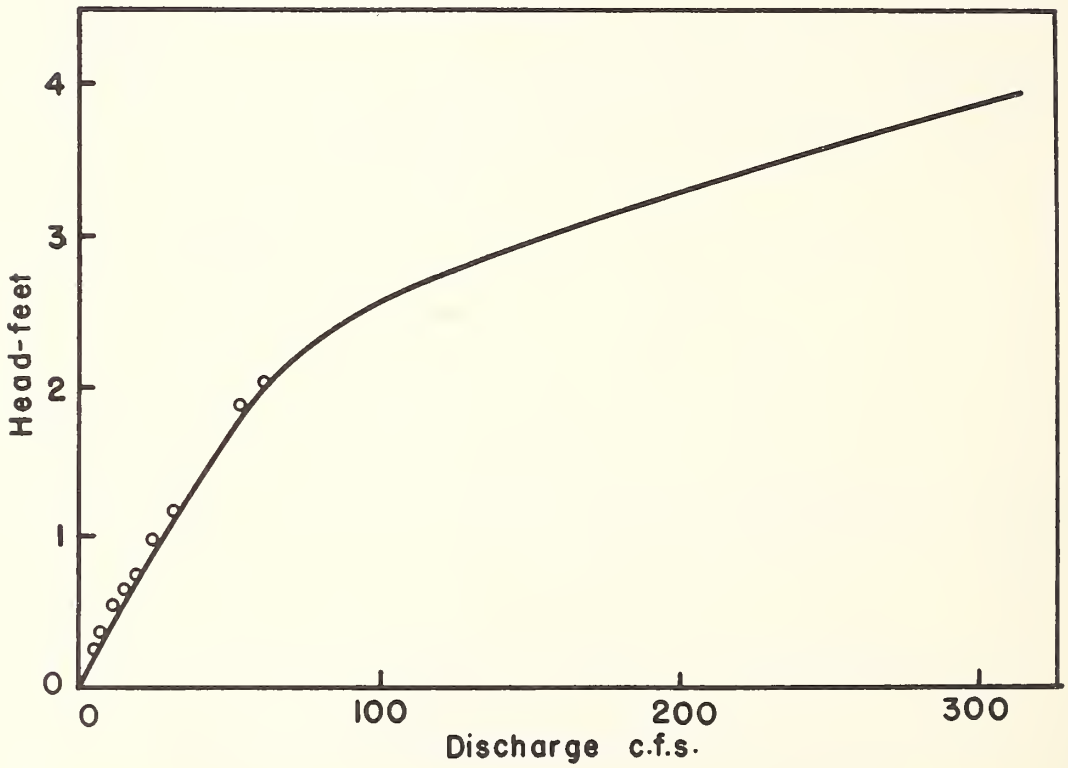



Figure 9.--The estimated head-discharge relationship for the flume shown in figures 7 and 8.

This station is suitable for measuring discharge in debris- and trash-laden streams. Current meter calibration is required to determine the head-discharge relationship.

## Alpbach Station Near Erstfeld, Bodenberg, Switzerland

The floor and the center channel of the station are built of masonry, and the walls are built of concrete. It is assumed that the masonry is more abrasion resistant than the concrete; therefore, it was used to counter the abrasive action of transported debris. Transition from the approach channel to the station is provided by curved training walls, which blend into the sidewalls without a break. See figure 10 for a sketch of this station and figure 11 for a photograph of it.

Figure 12 shows the head-discharge relationship. A Manning's n value of 0.018 was used for the masonry and 0.013 for the concrete to estimate the head-discharge relationship for this station. Appropriate weighting of these factors yielded a net Manning's n for the deepest flow equal to 0.0168. Good to fair sensitivity of discharge measurement is shown throughout the operating range.

This station is suitable for use in relatively steep, debris- and trash-laden streams. Current meter calibration is required.

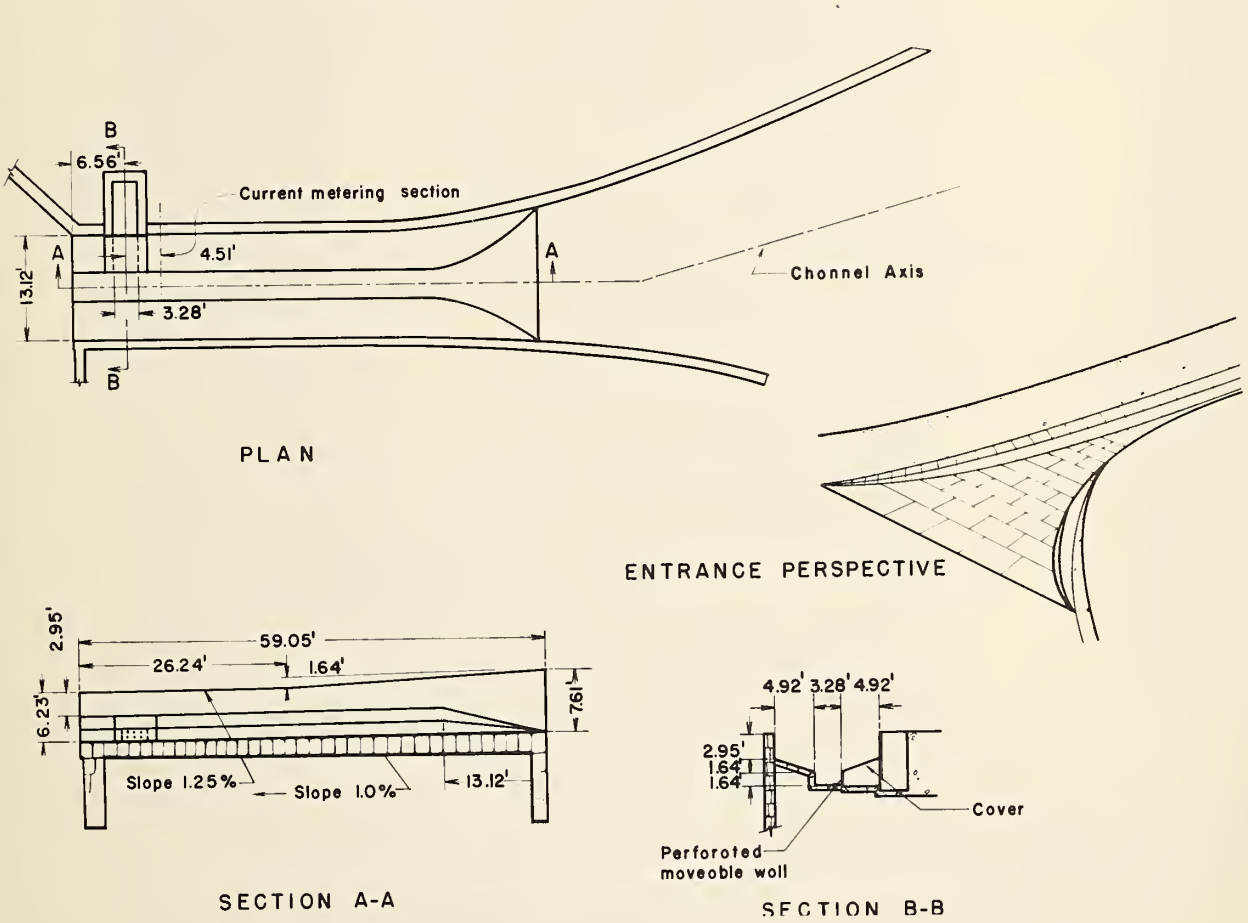



Figure 10.--Alpbach Water-Measuring Station near Erstfeld, Bodenberg, Switzerland. Sketch abstracted from plan numbers 27126, 27127, and 12579 of the Federal Water Service, Switzerland.

Figure 11.--Alpbach Water-Measuring Station near Erstfeld, Bodenberg, Switzerland.

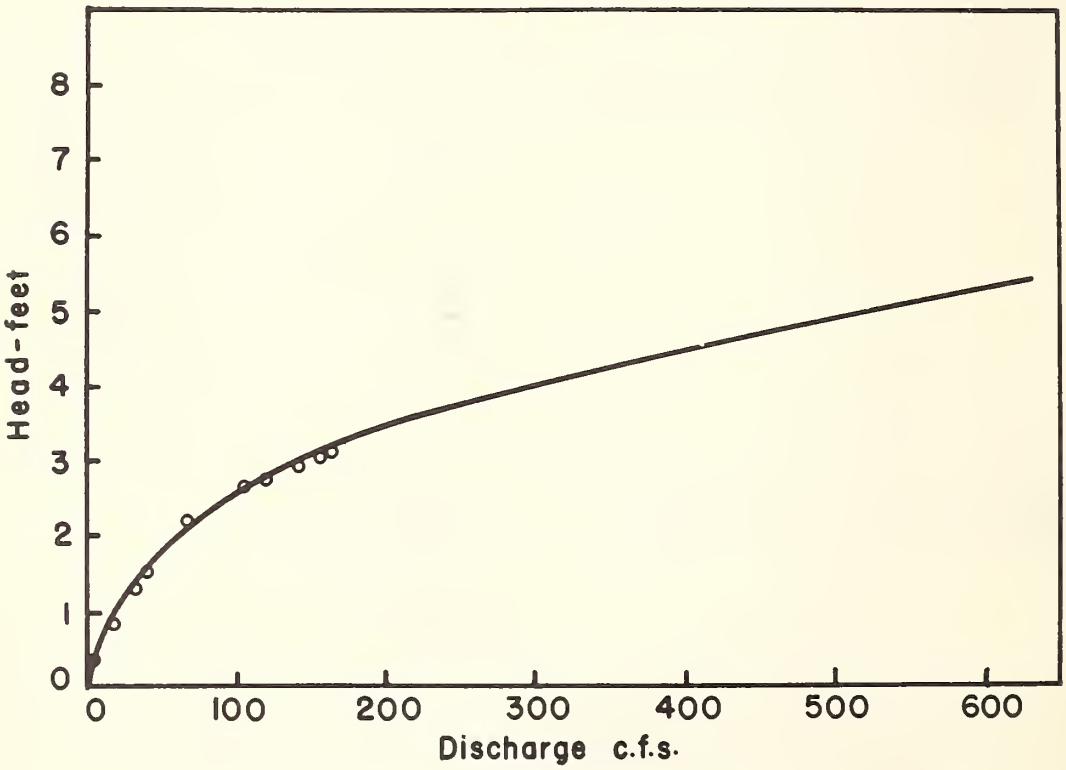



Figure 12.--The estimated head-discharge relationship for the flume shown in figures 10 and 11.